

## A SCIENTIFIC KEYBOARD FOR THE TYPEWRITER

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At the present time there is probably no other professional group which is more alert than are commercial teachers in re-examining their subjects in terms of content, equipment, methods of teaching, and their place in the curriculum. Always conscious of the value of their offerings, they are more and more showing their professional mindedness by critically evaluating accomplishments and techniques. Alive for some time to the contribution of the commercial subjects to so-called "producer" education, they are rapidly realizing their important relation also to "consumer" education about which we are hearing so much.

Typewriting has a vital place in the growing tendency to train both "producers" and "consumers." Educational leaders are insisting that typewriting, already established vocationally, should also become a personal, universal tool. This is a challenge to those interested in commercial education. It gives them the privilege of training more than a million and a half students each year; it brings them the obligation of developing in a much shorter time sufficient skill in typewriting to make it personally useful to their students.

The value of typing as a specific requirement, or as a supplementary skill, in getting a position has been universally accepted. This led to the training of a small per cent of our students as "commercial majors" in the hope that they may convert their skill into cash. No less important is the need for typing among the "academic majors," an even larger group, although less frequently has it been possible for public schools to satisfy their need. The best evidence on this point is probably that from Dr. White's study (Ref. 15). By investigating the academic records of university students with comparable high school records and intelligence test scores, he found that students who habitually use the typewriter in all their preparation of notebooks, reports, and other written work have a scholarship average higher by more than half a grade than do university students who are not able to work at the typewriter. This superiority in grades cannot be attributed to the instructors grading typed papers more liberally, because when regrading longhand papers in typed form, university instructors graded the typed papers an average of only .1 grade higher. The better grades are due to the student's work actually being of better quality because the typewriter is a more fluent mode of expression, encourages more and better editing, and saves a great deal of time and effort.

It is generally assumed that "marketable skill" in typewriting consists of a rate of at least 50 net words a minute. Under office conditions this performance frequently suffers a decrease of one-half to one-third, with many offices requiring a minimum of only 125 to 130 lines per hour, or an average of about 25 words per minute. Further, if the typewriter is to become a universal tool, the high school and college student should be able to compose at the machine--that is, convert his thoughts directly into typed form--and then edit his rough draft. To enable a person to work in front of a typewriter, typing should be automatic. But automatic typing is not accomplished at very low rates. Most typewriting teachers will agree that a minimum average of 40--preferably 50--net words per minute is desirable. A young man or woman who can type neatly and easily 3000 words per hour has a tool that will satisfy vocational needs, one which is extremely valuable for personal use, and one which can be efficient under practical conditions of work.



TABLE I

TYPEWRITING ATTAINMENT SCORES ON THE UNIVERSAL KEYBOARD IN NET WORDS PER MINUTE IN JUNIOR AND SENIOR HIGH SCHOOL AS FOUND BY KIBBY (1), KOCHKA (2), AND CARMICHAEL (3), AND TYPEWRITING ATTAINMENT SCORES ON THE SIMPLIFIED KEYBOARD AS FOUND IN THE CARNEGIE FOUNDATION STUDY.

| Senior High School |            |               |             |                | Junior High School      |             |                         |
|--------------------|------------|---------------|-------------|----------------|-------------------------|-------------|-------------------------|
| Keyboard           |            | --- Universal |             |                | Simplified              | Universal   | Simplified              |
| Study              |            | Kibby (a)     | Kochka      | Carmichael (b) | Carnegie (c) Foundation | Kibby (d)   | Carnegie (e) Foundation |
| Semester           | Percentile |               |             |                |                         |             |                         |
| I                  | 0          | 0             |             |                | 21                      | 0           | 17                      |
|                    | 25         | 10            |             |                | 31                      | 4           | 22                      |
|                    | 50         | <u>16.5</u>   |             |                | <u>37.5</u>             | <u>10.6</u> | <u>27.1</u>             |
|                    | 75         | 23            |             |                | 45                      | 16          | 31                      |
|                    | 100        | 52            |             |                | 71                      | 52          | 44                      |
| II                 | 0          | 0             | 10          |                |                         | 0           | 23                      |
|                    | 25         | 22            | 21          |                |                         | 15          | 30                      |
|                    | 50         | <u>28.4</u>   | <u>26.1</u> | <u>25.6</u>    |                         | <u>21.4</u> | <u>36.1</u>             |
|                    | 75         | 36.5          | 33          |                |                         | 29          | 42                      |
|                    | 100        | 71            | 59          |                |                         | 55          | 49                      |
| III                | 0          | 0             | 21          |                |                         | 0           |                         |
|                    | 25         | 30.5          | 31          |                |                         | 20          |                         |
|                    | 50         | <u>35.5</u>   | <u>35</u>   | <u>34.4</u>    |                         | <u>26.8</u> |                         |
|                    | 75         | 42.5          | 40          |                |                         | 35          |                         |
|                    | 100        | 64            | 64          |                |                         | 67          |                         |
| IV                 | 0          | 0             | 25          |                |                         | 0           |                         |
|                    | 25         | 35.5          | 36          |                |                         | 25          |                         |
|                    | 50         | <u>40.9</u>   | <u>41</u>   | <u>39.3</u>    |                         | <u>33.4</u> |                         |
|                    | 75         | 47.5          | 46          |                |                         | 40          |                         |
|                    | 100        | 76            | 66          |                |                         | 58          |                         |
| V                  | 0          |               | 31          |                |                         |             |                         |
|                    | 25         |               | 41          |                |                         |             |                         |
|                    | 50         |               | <u>45</u>   |                |                         |             |                         |
|                    | 75         |               | 49          |                |                         |             |                         |
|                    | 100        |               | 69          |                |                         |             |                         |
| VI                 | 0          |               | 34          |                |                         |             |                         |
|                    | 25         |               | 42          |                |                         |             |                         |
|                    | 50         |               | <u>47</u>   |                |                         |             |                         |
|                    | 75         |               | 52          |                |                         |             |                         |
|                    | 100        |               | 72          |                |                         |             |                         |

(a) An average of figures given for 50-60 minute periods in 1931 and 1932.

(b) An average of figures for schools of different classifications.

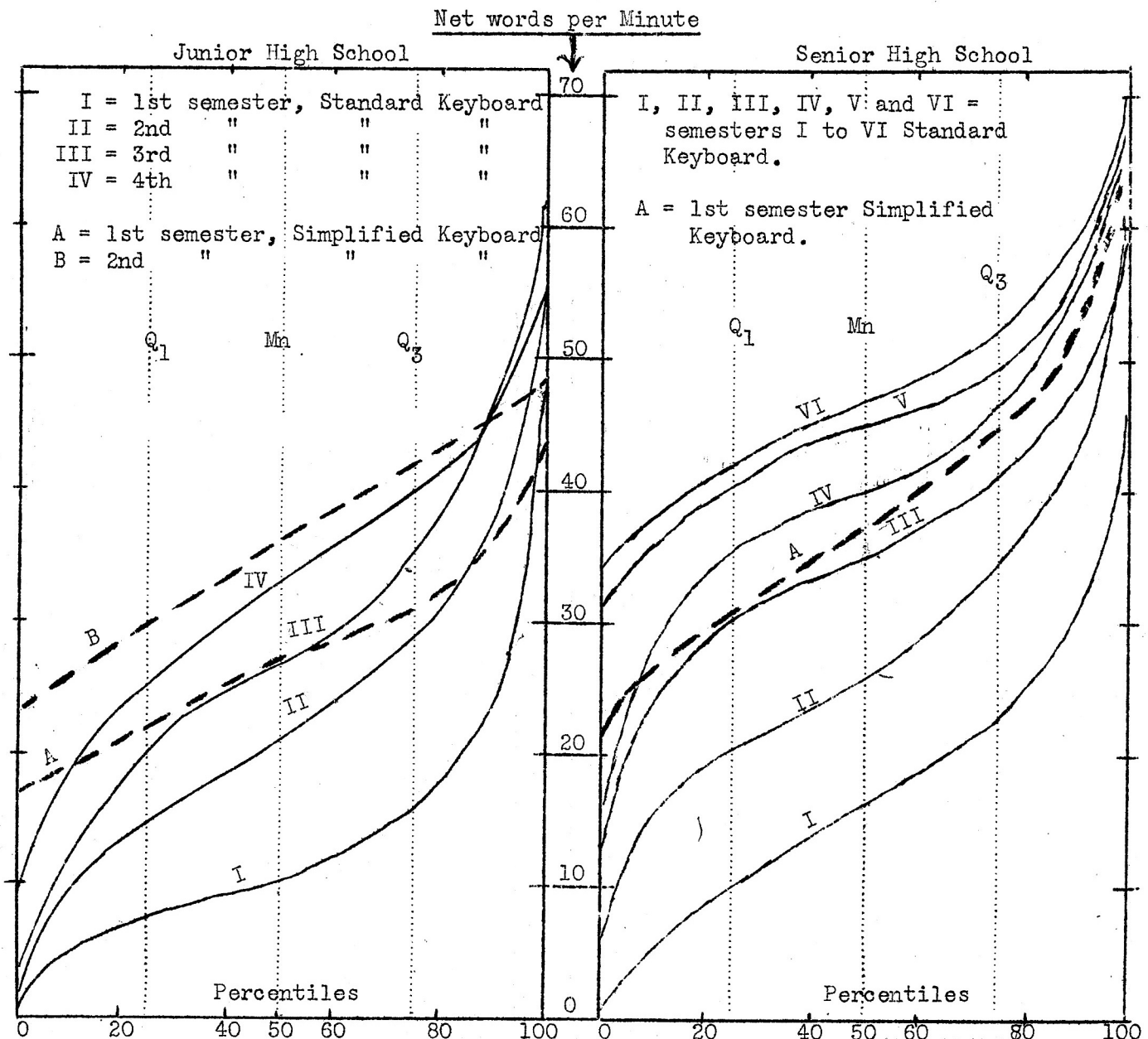
(c) Data secured from high school classes meeting 55 minutes daily.

(d) An average of figures given for 40-50 minute periods in 1931, '32.

(e) Data secured from junior high school classes meeting 45. min. daily.

(1), (2), (3). References next page.

Figure I -- percentile graphs illustrating comparative attainments in net words per minute on Universal and on Simplified Typewriter Keyboards. (Data illustrated for Universal Keyboard represent a composite mean of scores found by Kibby (1), Kochka (2) and Carmichael (3))



- (1) Ira W. Kibby, "A Study of Typewriting Accomplishments in California Secondary Schools," March, 1933, State Dept. of Educ., Sacramento, Calif.
- (2) Joseph L. Kochka, "Norms of Achievement in Speed and Accuracy in Typewriting, Balance Sheet, January, 1934, pp. 199-206.
- (3) V. H. Carmichael, "Objective measurement of accomplishment in Typewriting of High School Commercial Pupils in Indiana," Monographs in Educ. #12, University of Iowa Research Studies in Education, 1932.

Many will deny that an average attainment of 50 net words per minute can be realized. At least, such achievement is difficult and expensive to secure. Occasionally a school or a teacher claims such attainment in one semester or one year. A study of typewriting norms secured by such competent authorities as Kibby, Carmichael, and Kochka (References follow figure), discloses that the usual attainments are far from this goal. In fact, it was because of this wide gap between reliable norms and desirable goals that a study in time saving and teaching economies was undertaken at the University of Washington. These studies were later subsidized by the Carnegie Corporation of New York through the Carnegie Foundation for the Advancement of Teaching. Many of the findings of this study have appeared in the periodicals listed in the bibliography appended to this paper. The most important finding of this investigation was that the chief handicap to rapid acquisition of skill in typing is the typewriter keyboard itself. The first project in the solution of typing problems was, therefore, the development of a simplified and scientific keyboard.

The two-year program of the Carnegie Study in time saving in learning and teaching typewriting included more than 3000 students ranging in age from 8 to 71, in various schools. Data secured at the University of Washington and in public schools, among which Tacoma, Washington, was the pioneer, with the Simplified Keyboard indicate that comparable attainments can be secured in one-third to one-half the time required on the Universal Keyboard.

Average and percentile norms for approximately 100,000 junior and senior high school students in three widely separated parts of the United States, reported by Kibby, Carmichael, and Kochka, are surprisingly similar. In fact, it is because of their similarity that they have been averaged in order to make possible a graphic comparison with pupil attainments in the Carnegie Study. Such a technique is justifiable only, of course, because keyboards are being compared, not schools or state achievements. Comparable data on the scientific keyboard were secured with 325 junior high school and 250 senior high school students, in regular public school classes. Table I and Figure 1 present these comparisons.

From Table I and Figure 1, it seems clear that an average attainment of 40 or 50 net words per minute need not be as difficult, expensive, and time-consuming as it is on the present keyboard. In fact, both junior and senior high school students typing on the Simplified Keyboard in the Carnegie Study achieved average net scores somewhat superior to the average net scores reached in three semesters in junior and senior high schools on the Universal Keyboard.

In another section of the Carnegie experiment, 420 University students in 9 weeks averaged 16.1 net words per minute on the Universal Keyboard as compared with 33.8 net words per minute made on the Simplified Keyboard by 240 University students.

At the other end of the academic scale, 75 children ranging in age from 8 to 15 and in grade from the third to the eighth were included in an attempt to discover the best time to begin touch typing. That the results are easily comparable with attainments of high school students is shown in Table II, page 5.

Furthermore, at the end of their seventh week of Typing I, 65-7B students in the present semester in Steward Junior High School, Tacoma, Washington, had already reached an average attainment of 15.2 gross and 10.5 net words per minute; and a group of 65 Lincoln High School students had an average attainment of 28 gross and 22 net their seventh week.



TABLE II  
DISTRIBUTION OF TYPING SCORES OF SEVENTY-FIVE CHILDREN ACCORDING TO AGE<sup>1</sup>  
Dvorak Keyboard

| Age                  | Number pupils | Average gross words per minute | Average net words per minute | Average hours of instruction |
|----------------------|---------------|--------------------------------|------------------------------|------------------------------|
| Eight . . . . .      | 4             | 11                             | <u>9</u>                     | 28                           |
| Nine . . . . .       | 15            | 18                             | <u>14</u>                    | 29                           |
| Ten . . . . .        | 16            | 20.4                           | <u>16</u>                    | 28                           |
| Eleven . . . . .     | 17            | 20.2                           | <u>15.7</u>                  | 23                           |
| Twelve to fourteen . | 16            | 28.5                           | <u>21.4</u>                  | 25                           |
| Fifteen . . . . .    | 7             | 34                             | <u>24</u>                    | 20                           |

I. Ref. 11.

With the accomplishment norms of unselected groups raised as materially in one or two semesters as this evidence shows, it is inevitable, of course, that some individuals stand out. Remembering always that for useful writing speed and accuracy must go hand in hand, further evidence of the greater speed possible on the Simplified Keyboard is the accomplishment of 5 students, who, after only 4 to 6 months of training won 4 first places, 4 second places, and 3 third places in official competition with students who had had nine to twenty-seven months of training on the standard keyboard, at the International Commercial Schools Contest in Chicago in 1933 and 1934. The upper limit of speed, of course, will necessarily remain unproved for some time, inasmuch as no students so far have put in even 9 consecutive months of training, whereas the fastest writers on the old keyboard have usually required five to ten years to reach their outstanding performance and have had nearly twenty years to test the possibilities of the keyboard. That a net rate of 50 words a minute is within reach of many of our high school students at the end of their first semester instead of their third or fourth promises well for the upper limit of the new keyboard.

Although blue ribbons and gold medals impress the general public and bronze trophies are rightly a matter of school pride, teachers and administrators are more interested in average student performance than in the superiority of individual students on the scientific keyboard. We have already considered the important item of a tremendous saving in pupil time, with its implied corresponding saving in money and equipment. Let us now approach the matter of the greater usefulness of the Simplified Keyboard.

A scientific keyboard for the typewriter is not only more useful because it is easier to learn, faster, more accurate, and less fatiguing, but also because:

Unselected groups of 7B students can so far master touch typing in four weeks as to be able to type their English and Geography lessons, in a typing study hall entirely separate from typing class.

People fifty to seventy years of age can, in a short time, acquire sufficient skill in touch typing to be able to compose the letters or club reports that mean so much to them.

Busy teachers who have long felt the need of ability to compose on the typewriter can master the keyboard in a week, and in only a few weeks are able to do their school work and letter writing in the effortless fluent manner that intelligent people were always meant to use.

More students, especially the academic majors and the boys--the groups most slighted in the past--can be allowed to take typewriting, since in one semester all students can reach a useful level of accomplishment and in two semesters a majority can reach a superior level.

In spite of the group becoming more and more unselected as typewriting becomes a more universal tool subject, a very very small fraction (none, if attendance and conduct are good) of the students need fail to reach a reasonable standard of proficiency their first semester.

And finally, because it opens to thousands of people the opportunity to acquire what they never before have been able to acquire due to the time and effort involved--a skill that everyone agrees pays higher dividends, personally, academically, and professionally, than any other single subject in the curriculum!

Why does the Simplified Keyboard thus raise attainment to a desirable level in less time, while cutting costs and serving more people? It is because it is scientifically constructed--as compared with the unbalanced, illogical, and accidentally arranged old keyboard.

Many people, of course, had realized the possibility of increasing student attainment by improving the equipment used--notably the typewriter keyboard--and a few attempts were made to remedy the situation. But it was not until three years ago that an entirely scientific one was developed. An analysis of a large amount of typewritten material revealed that an impressive proportion of errors occurs on the most common words. These common words, by virtue of the continued practice devoted to their writing, should be most accurately typed. Further research pointed to the fact that the standard keyboard is inefficiently arranged for letter sequences occurring most frequently in written English. A motion picture study of the motions used in typing added significant data. All the data indicated that easy mastery of accurate typing could be secured only by an iconoclastic approach to the typewriter keyboard.

The scientific keyboard thus developed is easy to learn because fast, smooth, rhythmic typing is made possible by the elimination of practically all of the one-hand words, the balancing of the hand, finger, and row loads, the removal of the awkward hurdles, reaches, and stroking patterns, and the elimination of successive stroking with the same finger.

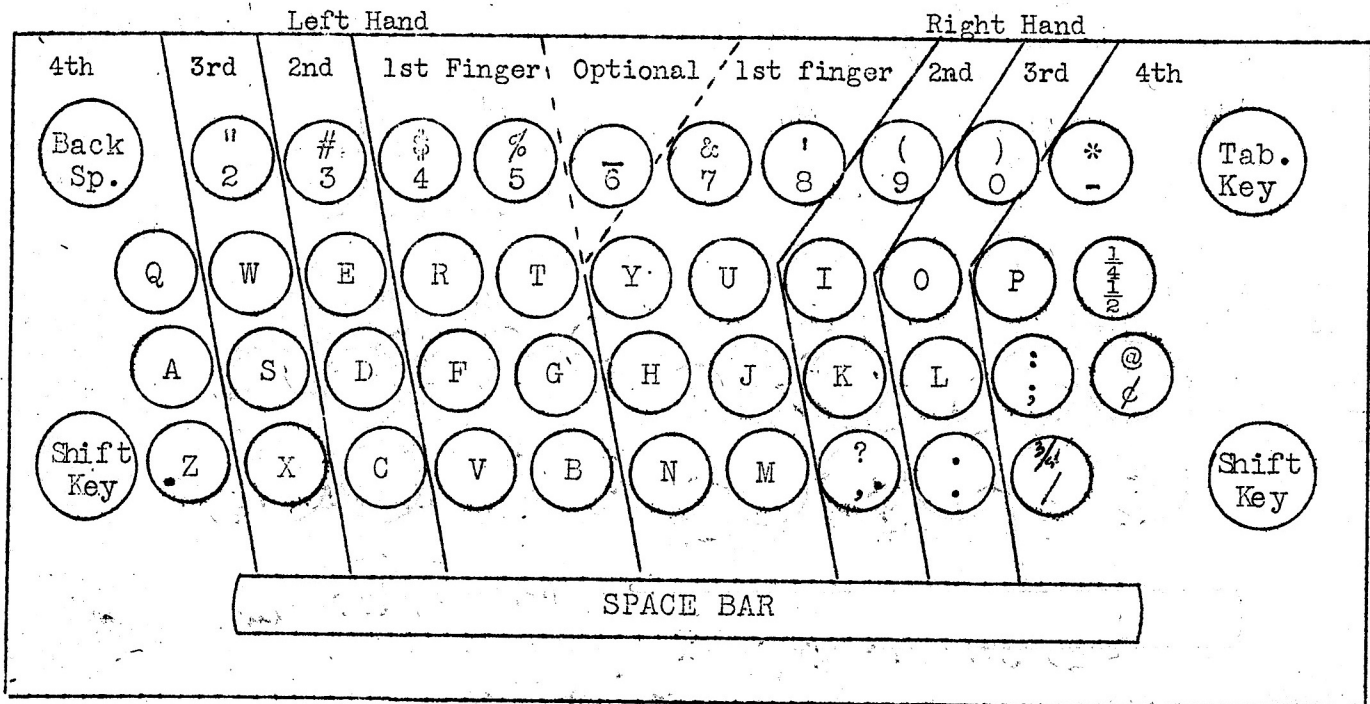
The new keyboard corrects the serious unbalance of the old keyboard in four definite ways. Instead of the left hand being required to do 59 per cent of the work, plus the carriage return, while the stronger right hand does only 41 per cents, now the loads are so arranged that the left hand does 45 percent of the work and the right hand 55 per cent. Used in a world composed chiefly of right-handed people, the old keyboard thus overloads the left hand by 47 per cent.

Not only is the left hand overloaded, but, by actual count, there are, on the old keyboard over 3000 words written by one hand alone, chiefly the left! Examples of these are: was, exaggerated, refers, deserve, created, road, faces, assess, arrest. In contrast to this, all but 69 one-hand words have been done away with on the new keyboard. Not one can be written in the right hand alone, since every syllable must have a vowel; and of those in the left hand, not more than 12 or 15 are at all common, 54 are mere monosyllables such as up or apc, and 32 are rarely-used words such as pyx or kayak. Notice how were, for instance, is written on the two keyboards. Notice the breakdown in rhythm and the cutting in half of rate on the old keyboard on such words as greatest and addressed. At once it is apparent that alternating the use of the two hands allows smooth, rhythmic stroking and decreases fatigue. Two-thirds of all ordinary typing is now the fastest known play between fingers of opposite hands.

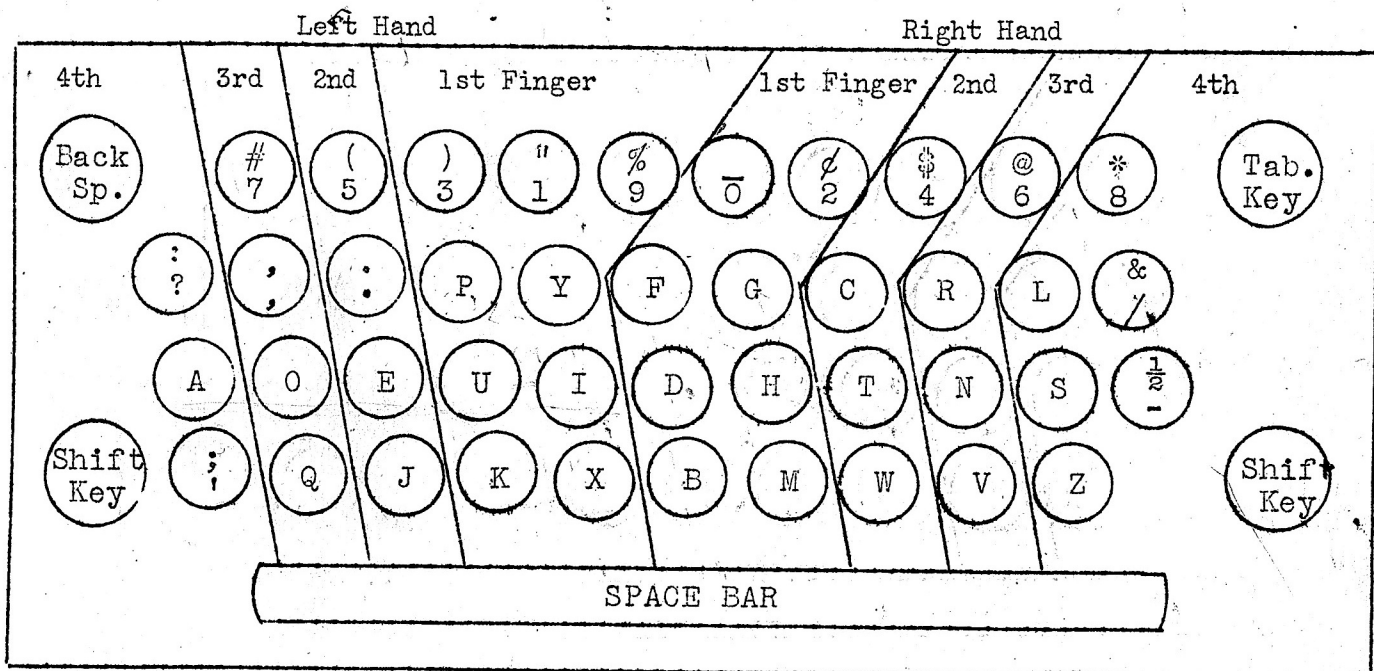
FIGURE II

DIAGRAMS OF UNIVERSAL AND OF DVORAK-DEALEY  
SIMPLIFIED TYPEWRITER KEYBOARDS

UNIVERSAL (OLD) TYPEWRITER KEYBOARD



DVORAK-DEALEY SIMPLIFIED TYPEWRITER KEYBOARD



Copyright and patented 1932  
by  
August Dvorak and W. L. Dealey

The third way in which the new keyboard corrects the lack of balance of the old is in regard to finger loads. As the following table shows, on the scientific keyboard there is perfect correlation ( $r=1.00$ ) between finger skill and finger load, while on the old keyboard the correlation between the rank of finger skill and finger loads is only ( $r=.43$ ).

TABLE III  
PER CENT OF TOTAL LOAD FOR EACH FINGER, RANK ON FINGER LOAD, AND RANK ON FINGER ABILITY COMPARED ON THE UNIVERSAL AND SIMPLIFIED KEYBOARDS

|  | Fingers         | Left Hand |      |      |      | : | Right Hand |      |      |                    |
|--|-----------------|-----------|------|------|------|---|------------|------|------|--------------------|
|  |                 | 4th       | 3rd  | 2nd  | 1st  | : | 1st        | 2nd  | 3rd  | 4th                |
| Universal  | % of total load | 7.9       | 7.8  | 17.8 | 22.2 | : | 20.9       | 8.4  | 13.3 | 1.7                |
| Simplified   | " " " "         | 8.3       | 10.0 | 13.6 | 13.8 | : | 17.9       | 14.8 | 13.0 | 8.6                |
| Universal  | Rank on load    | 6         | 7    | 3    | 1    | : | 2          | 5    | 4    | 8                  |
| Simplified   | " " " "         | 8         | 6    | 4    | 3    | : | 1          | 2    | 5    | 7                  |
| Rank on finger ability   |                 | 8         | 6    | 4    | 3    | : | 1          | 2    | 5    | 7                  |
| Universal--correlation between rank on finger skill and finger load-- $\rho = .74^+$ |                 |           |      |      |      |   |            |      |      |                    |
| Simplified--   |                 | "         | "    | "    | "    | " | "          | "    | "    | -- $\rho = 1.00$ . |

The fourth way in which the new keyboard corrects the defects of the old is in regard to hurdles and reaches. Slowed motion picture studies of typists' hand and finger motions used in an analysis of the relation of written English to the letter locations on the keyboard disclosed that fully 30 per cent of all two-letter sequences required hurdles and reaches--movements by the fingers of the same hand from the home row to the upper or lower rows or from the upper to the lower row or vice versa. These movements or strokes present special mental and physical difficulties and consequently are more slowly and less accurately made. The slowest and least accurate sequences are those requiring the stroking by the same finger. Examples of commonly-used same-finger-hurdle sequences are: ec, ce, my, ny, um, un, mu, nu. The relocation of the letters on the Simplified Keyboard eliminates intricate stroking patterns--complicated finger gymnastics--in typing words. Compare the typing of minimum, December, necessary, and excess on the two keyboards. The Simplified Keyboard eliminates 98 per cent of the same-finger hurdles, 70 per cent of the same-finger reaches, and 90 per cent of all hurdles and reaches required on the Universal Keyboard.

Table IV (adapted from Ref. 5) summarizes these comparisons of the two keyboards. Notice particularly that instead of a large percentage of common words being forced away from the middle row, most of the typing now runs smoothly on a genuine home row. In ordinary words strokes are forced away from that convenient central row for seven out of ten letters. Now, however, instead of 32 per cent of the writing being done on the middle row, 52 per cent on the upper row, and 16 per cent on the bottom row, the distribution of the writing according to rows is: 70 per cent on the home row, 22 per cent on the upper row, and 8 per cent on the bottom row. In other words, it is necessary to leave the home row only three times in ten strokes. Let us compare the writing of such words as: exert, December, abbreviate, reverse, minimum.

Thus we see how and why the scientific keyboard makes possible such tremendous and significant savings in time and money, and extends the usefulness of skill in typewriting to far more people. There are several other questions that teachers, administrators, and others frequently ask in regard to the scientific keyboard: Do the children like it? Is it more accurate? Do the business men want it? Must typists already well trained be re-trained? Are the machines any different? Will all our present machines have to be thrown away? Where can I get one equipped with the new keyboard? How much do they cost?



TABLE IV  
DATA ARRANGED TO PERMIT A BRIEF COMPARISON OF THE UNIVERSAL AND SIMPLIFIED  
TYPEWRITER KEYBOARDS

| Universal Keyboard   | Simplified Keyboard  |
|--|--|
| 1. Relatively common words typed with left hand alone--2600-(examples: <u>greatest</u> , <u>exaggerate</u> ).  | 1. Relatively common words typed with left hand alone--69, mostly mono-syllables (examples: <u>ox</u> , <u>puppy</u> , <u>keep</u> ) |
| 2. Sequential copy actually possible in left hand alone. (Example: We saw a ragged beggar as a car swerved.)   | 2. None.   |
| 3. Relatively common words typed with right hand alone--300-(examples: <u>no</u> , <u>union</u> , <u>unhook</u> , <u>Philippine</u> ).                   | 3. None.   |
| 4. <u>Left-hand over-load</u> --47%.   | 4. Right and left hand loads equated to average right and left hand skill and strength.  |
| 5. Tot. stroking load in upper row--52%.   | 5. 22%.  |
| 6. " " " " lower row--16%.   | 6. 8%.   |
| 7. " " " " "Homo" " --32%.   | 7. 70%.  |
| 8. Few words written in home row!.. (Examples: <u>hash</u> , <u>alfalfa</u> , <u>sash</u> , <u>ask</u> , <u>gash</u> .)                                  | 8. 35% of all words used in running copy on home row. (Example: The sun is so hot that I do not need to see the estate.)             |
| 9. Total letter sequences by awkward, slow, and difficult stroking patterns --30% (examples: <u>ec</u> , <u>ox</u> , <u>mu</u> , <u>um</u> , <u>my</u> ) | 9. 3%.   |
| 10. Most used number keys stroked by weakest and least skilled fingers.  | 10. Most used number keys stroked by ablest fingers.   |
| 11. Most used characters, i.e. ("), (\$), ('), (-), ( ), stroked by poorest fingers.   | 11. Most used characters stroked by ablest fingers.  |
| 12. Stroking keys in sequences requires complicated and intricate finger gymnastics, often in one hand, resulting in lack of rhythm.                     | 12. Stroking keys in sequences is simple, smooth, rhythmical--both hands working alternately.  |

Although several of these questions are outside the scope of this paper, they will be briefly considered at this time. Machines are no different; the letters on the keyboard and the type on the type bars have merely been rearranged. The cost and availability need not be considered here since the situation is the same as that with which you are familiar. No machines will need to be thrown away and no one needs to lose his job just because of the advent of a scientific typewriter keyboard. Briefly, this is because of the ease of converting a standard keyboard into a simplified keyboard and the comparative simplicity of re-training typists. There would seem to be no necessity for typists with a high degree of skill already established to change keyboards, although many prefer to do so. Business men are not ordinarily expected to be our educational leaders, especially in regard to problems of learning, but they can at least be counted on to be interested in a high degree of skill and a decrease in fatigue resulting from the elimination of unnecessary motions.

The accuracy of writing as well as the ease of learning the Simplified Keyboard, as has been pointed out, is due to the elimination of the awkward finger hurdles and reaches and lack of balance between hands, since there are no longer causes for breaks in rhythm which usually result in errors. Since all the results presented in this paper were in terms of net scores, using the 10-word error penalty of the International Rules, considerable evidence has already been presented in regard to the accuracy of the new keyboard.



As has already been pointed out, 3000 words are written entirely by one hand on the old keyboard. Table V, a comparison of errors on the two keyboards, shows that there are twice as many errors on one-hand words made by junior high, senior high, and junior college students on the old keyboard as compared with students who use both hands alternately on the new keyboard.

TABLE V

AVERAGE NUMBER OF ERRORS IN 276 TEN-MINUTE TESTS, IDENTICAL COPY, ON WORDS TYPED ENTIRELY BY ONE HAND ON THE UNIVERSAL KEYBOARD AND BY BOTH HANDS ON THE SIMPLIFIED<sup>1</sup>

|                    |            |    | Errors on one-hand words |         |
|--------------------|------------|----|--------------------------|---------|
|                    |            |    | Total                    | Average |
| No.<br>Papers      |            |    |                          |         |
| Junior High School | Universal  | 57 | 181                      | 3.18    |
|                    | Simplified | 37 | 69                       | 1.86    |
| Senior High School | Universal  | 38 | 174                      | 4.58    |
|                    | Simplified | 50 | 112                      | 2.24    |
| Junior College     | Universal  | 34 | 188                      | 5.53    |
|                    | Simplified | 60 | 125                      | 2.08    |

1. Ref. 28, 20

Also, data typical of the comparison of the total number of errors on all words are as shown in Table VI.

TABLE VI

AVERAGE NUMBER OF ERRORS PER STUDENT ON IDENTICAL COPY IN TYPICAL JUNIOR AND SENIOR HIGH SCHOOL CLASSES ON UNIVERSAL AND SIMPLIFIED TYPEWRITER KEYBOARDS

|                    |                     | No.<br>Students | Average errors<br>per student |
|--------------------|---------------------|-----------------|-------------------------------|
| Junior High School | Universal Keyboard  | 57              | 11.4                          |
|                    | Simplified Keyboard | 37              | 7.5                           |
| Senior High School | Universal Keyboard  | 38              | 17.0                          |
|                    | Simplified Keyboard | 50              | 8.9                           |

At the end of the second semester, a junior high school group averaged only 5 errors on a ten-minute test, with 25 per cent having less than 3; as did a senior high school group of 60 students their 5th week of Typing I. A 7B class showed the high degree of accuracy possible on the new keyboard, when, their 5th week, 20 per cent had no errors, 20 per cent 1 error, and 20 per cent 2 errors, with only one child having as many as 5 on a five-minute test. This was in spite of the fact that, for 11- and 12-year old students, errors due to reading, spelling, and punctuation habits being imperfectly formed are more apt to occur.

Further very interesting evidence in regard to accuracy is the error data on typewriting demons. By determining the frequency of typewriting errors on words in the Ayres list, Dr. Dvorak and Miss Ford (Ref. 6) found that, on the Universal Keyboard, certain words--easy to spell--are mistyped with frequencies out of proportion to their use. According to their findings, approximately half of all the errors (11,484) were made on 100 different but frequently-used words (such as: the, to, of, and, is, which, it, that, when, for, with, have, be). All but 7 of these are monosyllables (very, about, letter, other, truly, after, over). This means that some factor other than chance was operating to cause a larger incidence of errors than the frequency of use of the word would indicate. Since the words with high frequencies of errors were words which require intricate and complicated fingering or striking patterns, presumably the keyboard was the factor operating to increase the errors.

Mr. Dwight Davis made the same kind of study (Ref. 29) with the words in the Ayres list, using students with 6-9 weeks of training on the Simplified Keyboard. He likewise found that certain words caused more errors than would be expected by pure chance, but the striking thing is, that with few exceptions, the words that head his frequency of error list are long and less used (beautiful, everything, oblige, possible, importance, committee, difference, arrangement), while the simple words which monopolize the errors on the Universal Keyboard are at the bottom of the list on the Simplified Keyboard. In other words, there is a high degree of accuracy on the Simplified Keyboard on the 100 simple words which, on the Universal Keyboard, cause too large a proportion of errors. It is of further interest to note that approximately half of Dvorak and Ford's 100 "Typewriting Demons" (Ref. 6) are exclusively or with the exception of one letter typed by one hand.

An even more fundamental approach to the problem is furnished by a study of the types and frequencies of different letter errors on the two keyboards. Few would disagree with the assumption that errors are due either to factors entirely within the typist, to factors in the relationship between the typist and the typewriter--essentially the keyboard--or to both. If the typist's mental and physical mechanism alone is responsible for letter errors, then the correlation between the frequency of letter usage and letter errors should be perfect ( $r = 1.00$ ). To the extent that this correlation is less than perfect, some factor other than the typist's tendency toward chance errors is operating. Actually, the correlation between the rank on frequency of use of each letter and the rank on frequency of mistyping each letter, as found by Dr. Lessenberry (1) in his study of over 60,000

1. D. D. Lessenberry, "Error Chart" and "Analysis of Errors," L. C. Smith and Corona Typewriters, Inc., 1928.

letter errors, is .72. Far from being high, a correlation coefficient of .72 means that predicting the rank of letter error frequencies from the rank on frequency of use would be only 31 per cent better than pure guessing. But if pure chance (the human factor) alone were responsible for letter errors, the more times a letter were used the more times would it be mistyped and the rank of a letter's error frequency would correspond exactly to its rank on use. Consequently it is logical to conclude that the human factor is responsible for 31 per cent of the letter errors on the Universal Keyboard and the typewriter for 69 per cent.

Davis (Ref. 28, 29) tabulated letter errors on the Simplified Keyboard in a manner similar to Dr. Lessenberry's pioneer work. The correlation between the ranks on usage and errors for the different letters gave the highly desirable result of  $r = .953$ . This result, interpreted as above, means the human factor is responsible for 70 per cent of the errors, the typewriter is responsible for only 30 per cent. In other words, on the Simplified Keyboard the typewriter is responsible for 30 per cent of the letter errors instead of 69 per cent. This means that, on the Universal Keyboard, 2.3 times as many letter errors are directly traceable to the typewriter as on the Simplified Keyboard.

Up to this point, we have briefly, but carefully, examined the evidence of the superiority of the Simplified Keyboard in the classroom with students of various ages, and have observed why the scientific construction of the Simplified Keyboard makes such saving in time possible. We have noticed also its greater accuracy and usefulness. There remains another criterion upon which it should be judged, however, notably its relation to the most characteristic phases of progressive teaching of typewriting. For convenience, these might be considered under materials and rhythm.

Inherent in its very construction is the scientific keyboard's close relation to the best teaching materials. Since the ten letters on the home row include the vowels and the five consonants which make up 70 per cent of all ordinary type-writing, interesting and meaningful sentences and paragraphs can be typed the very first day, with the TYPE-PACER set at 10 or 12 words a minute, with a high degree of accuracy. Such material and such success have a very decided effect on student interest and morale. The upper- and lower-row letters can be introduced in relation to the home row in useful, high-frequency sequences. At the end of one week students have written their personal letters, and at the end of four weeks even young students are allowed to type their school work during study periods when a typing work-room is available. Although it is true that many sincere efforts have been made in the past to prepare and use the best teaching materials in spite of the keyboard, such attempts have always fallen short of their goal because of the handicap of an awkward, illogical, unbalanced keyboard. For no teaching technique or materials can alter the fact that in writing the English language on the old keyboard 7 strokes out of 10 are forced away from the home row. In fact, whole paragraphs of copy can be written for the left hand alone. (1) Such keyboard handicaps are now removed and no longer necessary are dull, monotonous, meaningless letter drills that one finds all too often the first five or six weeks of Typing I.

1. A feast was served at her cafe. We were aware her fare was better. We ate red crab, stewed beets, raw cabbage, sweet tarts, bread, beer, wafers. Beef stew was scarce. Bad beverages were scarce. Dessert tasted best.

There is practically general agreement as to the importance (Ref. 10) of developing rhythm in the teaching of typewriting. Whether the teacher uses the modern TYPE-PACER (Ref. 22, 27), Dictaphone rhythm rings, or some less progressive and less successful method of developing the desired pace at any level of instruction, it is almost self-evident that the scientific keyboard allows and demands a smooth and effortless rate from the very start. With 98 per cent of the same-finger hurdles and 90 per cent of the reaches eliminated rhythm becomes much easier. With both hands called into play for alternate stroking of sequences, rhythm is practically insured. Thus, on the Simplified Keyboard, students type at the desired pace with calmness, poise, confidence, and freedom from tension and fear. These mental and emotional results of easily maintained rhythm enhance student achievement and decrease fatigue.

What, then, are the significant implications of a scientific keyboard for the typewriter? First, it makes possible a tremendous saving in the cost of teaching typewriting. Although per pupil costs are difficult to secure, a conservative estimate is probably at least \$35 to \$40 per typing student per year. On the basis of data that shows that the present typewriting attainments can be secured in one-half the time, it seems safe to conclude that one-half the present cost could be saved (Ref. 3). Generally adopted, the Simplified Keyboard would result in an annual saving of approximately \$15,000,000 to \$20,000,000 on the present cost of teaching typewriting in our schools.

Second, many high schools cannot now teach typewriting to all students who wish to elect the subject. The new keyboard would let twice as many students be accommodated with the same equipment and teachers. Typewriting teachers could have a part in the education of all of our high school students. Eventually all high school and college students would be able to type well, and one would no longer hear adults lamenting the fact that they can't type. The public is ready to make typewriting a required subject in junior and senior high school. At present most schools cannot supply facilities to equal the demand. The Simplified Keyboard would make this possible.

Third, saving student and teacher time is an educational economy even though it does not reduce school budgets because it would make our schools more efficient. Commercial departments would benefit in that the student would be released for other subjects--for a course in elementary household and personal bookkeeping, for instance, the need for which has been rather clearly shown. The commercial teacher's activities and usefulness would be increased rather than curtailed. The English teacher's instruction would be supplemented and enhanced because a universal tool in both the junior and senior high school is not only a more fluent mode of expression (Ref. 1, 11) but it encourages and allows editing and re-writing, and permits matters of punctuation, arrangement, etc. to be taught incidentally and effectively in a much shorter time.

From the standpoint of the curriculum, there are several desirable changes that the Simplified Keyboard will make possible. One semester of typing as a personal tool (entirely non-vocational) will be required of all students in the Junior High school, beginning with the 7th grade, and in the Senior High school an additional semester will be elective beginning with the 10th grade. Even the less able student will have good skill at the end of one semester, for the absence of zero scores (page 3) indicates that the Simplified Keyboard has special advantages for the slow student, and any rate over approximately 15 words a minute gross is faster and more legible than handwriting. For commercial majors or students interested in the vocational aspects of typewriting, a third semester, preferably in the Senior year, could be offered to those who show exceptional promise. This would be an advanced course to develop really competent typists who not only could meet the highest stenographic requirements in speed and accuracy, but would be familiar with the application of typing to law, insurance, banking, and other special professional and commercial fields.

In conclusion, then, all the experimentation with the Simplified Keyboard has given results far above even the designers' expectations. Carnegie experiments and public school use have shown its value. The changes that it presages are tremendously significant educationally and socially the while lacking the dangerous or destructive aspects often associated with revolutionary changes. Typing should be a universal tool. Our students and teachers have a right to as high a degree of success as is humanly possible. The Simplified Keyboard will bring to written expression, as compared with out-worn modes, the same smoothness and speed that a fast automobile or aeroplane has brought to transportation since the days of the ex-cart.



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